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Photon -Charm Production in $p\bar{p}$ Collisions at $\sqrt{s}$ = 1.8 TeV

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PHOTON - CHARM PRODUCTION IN $P\bar{P}$ COLLISIONS AT $\sqrt{S} = 1.8$ TeV

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ABSTRACT

We present preliminary results of a measurement of inclusive photon-charm production in p̄p collisions. Using data collected by the CDF experiment during the 1992-1993 Tevatron collider run, we have measured the inclusive photon-muon cross section, and estimated the decay-in-flight and punch-through backgrounds. We compare our measured photon-muon cross section and photon E_T spectrum to Pythia predictions for the charm Compton contribution.

1. Introduction

The measurement of the photon-charm process is interesting because it is believed that the charm Compton process $gc \to \gamma c$ is the dominant contribution, and that it may thus be possible to directly measure the charm density of the proton at LO accuracy. The charm structure function is important for current and future hadron colliders, but at present is poorly understood. For instance, at $Q = 80$GeV and $x < 0.005$, CTEQ2M predicts that more than 20% of available quarks are charm, while there are to date no measurements of the charm structure function for the x ranges probed by either the LHC or the Tevatron.

CDF has several analyses in progress attempting to measure associated photon-charm production.Here we will discuss a measurement of the photon-muon cross section, and show why we believe this cross section to be dominated by the charm Compton process $gc \to \gamma c \to \gamma\mu X$. Theoretical estimates lead us to believe that the bottom-to-charm ratio in direct photon production is about 1:8,[1] and that the gluon-splitting contribution to the photon-charm process is only about 10%.

2. Data

A data sample was selected using the 16 GeV photon trigger from the CDF 1992-1993 run. The events were required to have an isolated electromagnetic energy cluster with $|\eta| < 1.0$ and $E_T > 16.0$, and no track pointing at the cluster. The offline photon cuts used in this analysis are identical to those used in the CDF inclusive photon analysis.[2] This sample corresponded to an integrated luminosity of 15.0pb^{-1}.

Photon-muon events were selected by additionally requiring a good offline muon in the central region. For this analysis, a good muon was defined by a coincidence in

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the inner and outer muon chambers, and a good track-stub match for both the inner and outer stubs. These requirements left us with 127 events.

3. Backgrounds

The backgrounds for a photon - muon analysis are fairly easy to classify. A photon can be faked by a neutral meson like a π^o or an η, and a muon can be faked by a decay-in-flight of a kaon or a pion or by a punch-through (a jet which isn't completely absorbed by the calorimeter).

The photon backgrounds were statistically subtracted using the profile method described in the CDF inclusive photon analysis.[2] Briefly, a χ^2 was assigned to the transverse shower profile of the photon candidate, and on this basis the event was assigned a photon weight determined from Monte Carlo.

The muon backgrounds were estimated analytically and subtracted from the data. The punch-through rate was found to be negligible when we required inner/outer coincidence. The decay-in-flight rate we calculated from the charged particle spectrum of the photon sample.

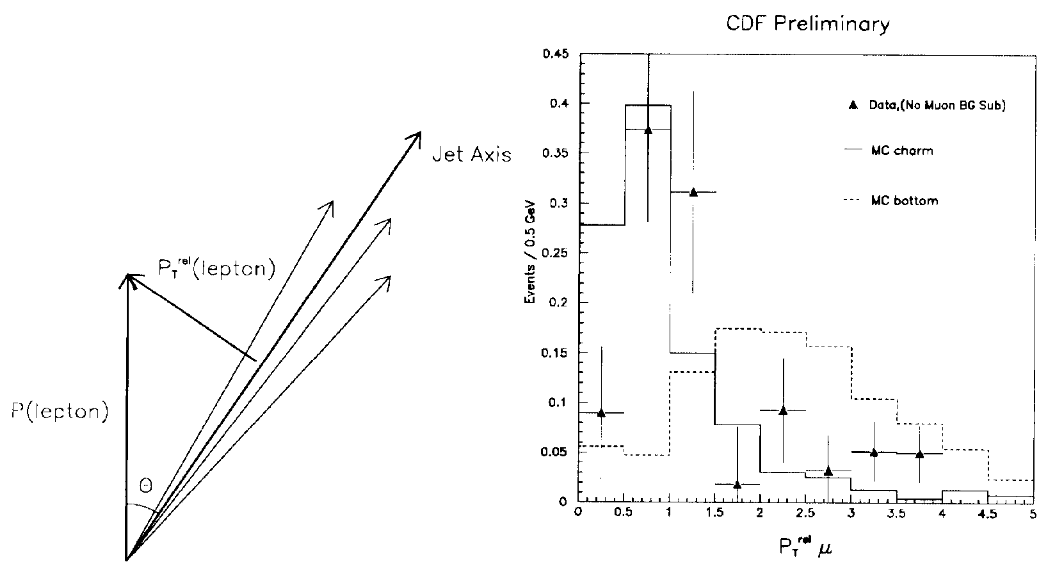


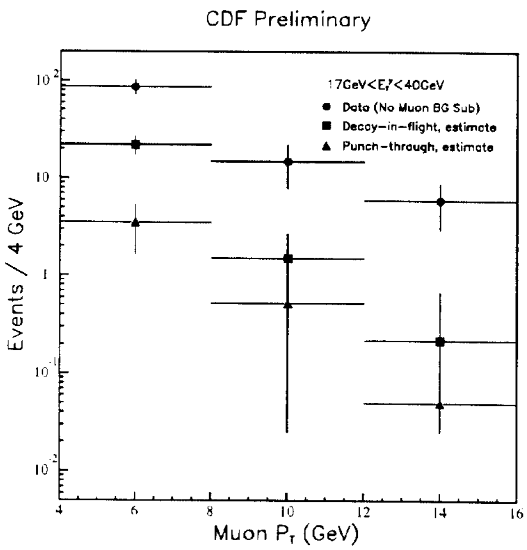
Fig. 1. **a)** Diagram explaining the calculation of P_T^{rel}. **b)** P_T^{rel} distribution of the data, compared to MC of photon - charm and photon - bottom.

Finally, in order to ensure that our cuts are efficient for charm, we used P_T^{rel} to estimate the relative charm/bottom content of our sample. The P_T^{rel} of the muon is defined to be the P_T of the muon relative to the nearest jet, as shown in Fig. 1a. Figure 1b shows the P_T^{rel} distribution for our data, compared to Pythia predictions for both photon-charm and photon-bottom, and our data is clearly more consistent with charm than with bottom.

4. Conclusions

After background subtractions, we are left with $80 \pm 22(\text{stat.}) \pm 20(\text{syst.})$ events. The muon P_T spectrum is shown in Fig. 2a, with the decay-in-flight and punch-through

through estimates superimposed. Figure 2b shows the measured differential cross section for associated photon-muon production. If one assumes that the bottom contamination of our sample is small, and that the gluon-splitting contribution is negligible in comparison to the charm Compton signal, then one can compare our data to a Monte Carlo of the charm Compton contribution to the photon-muon cross section. In Fig. 2b the Pythia prediction for the charm Compton process is superimposed on the data.



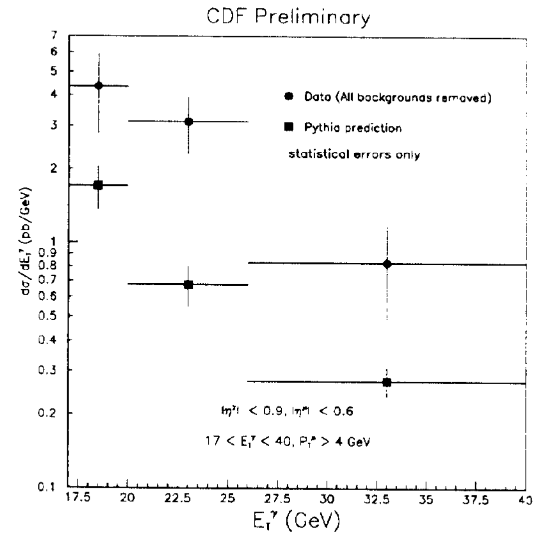


Fig. 2. **a)** P_T^μ spectrum for the data, with decay-in-flight and punch-through estimates superimposed. **b)** Measured photon - muon differential cross section.

If one integrates the differential cross sections in Fig. 2b one finds a measured cross section of 43 ± 12pb(stat.) ± 11pb(syst.) for $17 < E_T^\gamma < 40$GeV, $P_T^\mu > 4$GeV,$|\eta^\gamma| < 0.9$ and $|\eta^\mu| < 0.6$. The corresponding Pythia prediction for the charm Compton process alone is 15 ± 3pb, for MRSD0 structure functions with $q^2 = \hat{s}$, where the error includes only the statistical error due to the number of events simulated. We emphasize that there are potentially large systematic uncertainties in the Monte Carlo cross section. Structure function choice, q^2 choice, and modeling of initial and final state parton shower result in roughly a factor of 2 systematic uncertainty. Work is in progress to better quantify these issues.

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